HYPOTHESIS

Why do we have apocrine and sebaceous glands?

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SUMMARY

The secretions of sebaceous and apocrine glands fulfil an important thermoregulatory role in cold-stressed and heat-stressed hunter–gatherers. In hot conditions the secretions emulsify eccrine sweat and thus encourage the formation of a sweat sheet and discourage the formation and loss of sweat drops from the skin. In colder conditions sebum changes its nature and repels rain from skin and hair.

INTRODUCTION

The only two mammals capable of sustained running are horses and human beings. Copious sweat is produced in horses by apocrine glands[1] and in humans by eccrine glands[2]. The role of the eccrine sweat glands in human thermoregulation is evident, but what functions do apocrine and sebaceous glands fulfil? There has been surprisingly little hypothesizing about this. It is not even certain that the original simple division of human sweat glands into apocrine and eccrine is realistic[3–5]. It will be assumed here that the apocrine glands are a reality—that their dismissal in the past as no more than 'atavistic scent glands' was erroneous[6].

The role of sebaceous glands in humans has been regarded as uncertain, but the fact that they are under complex hormonal control argues against their being vestigial[7]. In humans sebaceous glands occur over much of the body. They are usually associated with hair follicles and are particularly well developed in certain areas such as the scalp, face, upper back and chest[8,9]. It is noteworthy that, in a naked bipedal hominine, these are the areas most exposed to weather and rain.

THE HYPOTHESES

In the long evolutionary history of man, powerful selection factors would have operated on hunter–gatherers who relied on sustained endurance running to hunt middle-sized mobile game.

On a hot savannah plain success would have attended those hunters best able to defer dehydration and resist the extreme thermoregulatory challenge[10]. Adaptations to contain the loss of sweat drops from the body surface would have been crucial. An unstable sweat drop that falls to the ground is a sweat drop wasted, for it will have contributed little to evaporative cooling of the skin surface and its loss will hasten dehydration. The retention of sweat on the skin surface will be encouraged by anything that lowers the surface tension of the sweat, so that it forms a sheet rather than drops. In passing it may be noted that the need to retain sweat on near-vertical surfaces has led to morphological adaptations in addition to the physiological ones. The features of the face may be explained in part by the need for platforms to check, and hair tufts to catch, the descending sweat drops generated from the gland-rich scalp, a specialized heat-dissipating organ. Hence supra-orbital tori, flared nostrils, everted upper lip, a chin (a late development in our evolutionary history) and hair remnants such as eyebrows and moustache. Sternal and pubic helical hair serve the same function. Pubic hair extends up the central abdominal gutter in the male to meet and trap the descending sweat drops; endomorphic females have no central gutter and the superior surface of the pubic hair is thus horizontal. Above all there must be no sweat drops on the pumping hands, hence there is only an insensible loss of sweat from the palms (unless, strangely, the sweating is prompted by anxiety[2]).

The ability of the skin to shed water suggests that it is intrinsically hydrophobic with a low surface-free energy. Very pure water has a surface tension of about 72 dynes/cm, which declines to about 30–50 dynes/cm if a finger is inserted into the water (Bangham AD, Personal communication). Though any contaminant might cause this, it may be noted that the surface tension plunges if the finger is first inserted in the ear and that cerumen is only 'stale dammed sebum'[11]. It would seem that there is some secretion on the skin that fulfils a surfactant role and discourages drop formation. The somewhat oily secretions from apocrine glands are likely to have emulsifying properties for they have been observed to spread over the skin in a film and usually not to form droplets[12,13].

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The sebum from sebaceous glands will also contribute to the surfactant action. Bacterial action on the skin forms free fatty acids from the triglycerides and wax esters found in sebum[7]. Below about 30 °C the fluid consistency of the sebum fraction changes and it suddenly assumes either a solid or a highly viscous character[14], but at and above 30 °C sebum it has a surface tension of about 25 dynes/cm and would thus qualify as a potential emulsifier of sweat.

Thus sebum has three thermoregulatory roles. The first is to coat the straight hair of northern populations and create a water-repellent pelage. Southern populations have non-matting helical scalp hair which serves the double function of reflecting sunlight whilst at the same time allowing the 'breeze-over-body', generated by running, to penetrate the hair and cool the sweaty scalp. Second, at higher temperatures sebum acts as a surfactant for eccrine secretions. Third, at lower temperatures it repels rain on the exposed skin. It may be postulated, therefore, that the outcome of secretory interactions is for an externally generated fluid, rain, to be projected off the skin in cool wet conditions, whilst in hot conditions the internally generated fluid, eccrine sweat, is encouraged to spread in a film across the skin and to be retained on the surface. This would be a remarkable temperature-dependent switch in function on the part of sebum.

CONCLUSION

The secretions of apocrine and sebaceous glands were important in the thermoregulation of hunter–gatherers and remain so for those who indulge in modern hunting-substitute activities such as energetic games and marathon running.

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